Using Animated Videos for Science Engagement and Science Learning

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Abstract

Some scientific topics, such as those that encompass "invisible" biological processes, are difficult to address with a young public. The resources used to introduce these processes should be attractive, in a suitable language for the target audience - simple but accurate. In order to introduce concepts of cells and evolution to children from 6 to 12 years old, we developed short animated videos. Students found these videos entertaining and teachers considered them to be a good educational resource to convey scientific concepts that are difficult to explain or that are not part of the school curriculum. To further explore whether these animated videos are good tools for informal learning and if they could be used as a 'stand-alone' educational resource, we conducted a study with one of the videos in 4th grade classes at three Portuguese Primary Schools. Each class was asked either to watch the video (with no further support), to read a book containing still images of the video, or to watch the video and perform an accompanying hands-on activity. When assessing knowledge acquisition, our results indicate that all the students gain

knowledge, independently of the task executed, but those that only watched the video scored marginally less than the other two groups in the follow-up assessment (one month after the task was carried out). Our data suggests that animated videos serve the purpose of engaging students, but may be better educational resources, when used in the classroom as exploratory material, together with other resources.

Introduction

Science education is important not only for generating new scientists, but also to maintain a high level of scientific literacy and to help develop critical thinking amongst the youngest and thus contribute to their development into informed citizens. Schools are the key *hotspots* for formal science learning, with increasingly new tools and platforms – many of them Web based - being used for both formal and informal science learning.

Some reports support that science education should start in primary schools, at a stage when mistakes or misconceptions first arise, and when children's attitudes towards science are being developed (1, 2, 3). But during primary school, science subjects may not have sufficient room in the classroom, since focus is often given to literacy and numeracy. On the other hand, it is difficult to address topics that contemplate processes that are invisible to the naked eye, such as those that occur in the cell, or that take place over long periods of time, like evolution. Even for middle school, high school and undergraduate students, "invisible" processes, such as those underlying genetics, for instance, have been found abstract and difficult (4, 5, 6, 7, 8). Hence, when considering science learning by young children, we face two challenges: 1) finding room in the Primary School curricula to teach science, and 2) presenting interesting resources, that simultaneously engage the students and foster science learning in a simple but accurate way.

Several studies have analysed the potential benefits of animated videos in the classroom (9, 10). Here, we discuss the use of short animated videos as a resource to enthuse young people about science, and at the same time teach them key biological concepts. We explored whether these short animated videos are effective in promoting knowledge, and in being used in the classroom as a stand-alone educational resource.

Methodology

Research Participants

Participants in this study included 9 teachers and 172 students from the 4th grade (9-10 years old) from 3 Primary Schools (schools located in Lisbon, Oeiras and Ericeira). Schools participating in the study are state schools with similar socioeconomics status.

Study Design

Students were allocated to one of three experimental groups: 'Me and my body' video (N = 53), book (N = 60), or video plus hands-on activity (N = 59).

Experimental Group 1 – Video: Students were invited to watch a 7 minute video, narrated in Portuguese (the participants' native language). The version with English subtitles is available at: http://www.youtube.com/watch?v=3l9_inq6vaQ&list=UUlv8o8SQvDGMzBawdZa3dRw

Experimental Group 2 – Book: Students were invited to read a book containing exactly the same content that was narrated in the video, including text and frames of the video.

Experimental Group 3 – Video + hands on activity: Students first engaged in a board-game that consisted in matching recognizable organs to a human body. The board game allowed students to revise concepts previously learnt as part of the curriculum. This activity lasted approximately 10 minutes. Afterwards, students watched the video (the same video used by the experimental group 1), and were asked questions about what they had learned anew. The video describes some of the different types of cell in the body, their function and how this diversity underlies the different organs in the body. Students then engaged in a second game based on the human body board game, to establish a correspondence between a cell type and its organ, and to identify the cell's name and function. The interaction with students after watching the video lasted approximately 15 minutes. Finally, students were invited to build a cell of their choice, using play dough.

Evaluation of knowledge acquisition

Students' prior knowledge on the subject of cell types was assessed by a picture-based questionnaire, filled in before each experimental group performed their task (Phase

1). Learner's acquisition and retention of new scientific concepts were assessed immediately after performing the task (Phase 2) and again one month after the task (Phase 3). Pre- and post-task questionnaires had identical questions. Pictures used in the questionnaires were the same as those used in the video or the book. There was no time limit to answer the questionnaire, but students were expected to do so in less than 10 minutes. The questionnaires did not included personal or demographic questions.

Teachers' participation

Prior to the beginning of the study, teachers were informed of the purpose of the study and provided with guidelines on how to introduce the different material in the classroom. Teachers were asked to present the video and the book without teaching further concepts or establishing a link to previous curricular content. The book and video activities were introduced in the classroom by the teacher, whereas the video plus hands-on activity was facilitated by the authors of the study. Questionnaires were given out and collected by teachers.

Assessment of Teachers' perceptions

Teachers were interviewed at the end of the study with the goal of understanding their perceptions on the efficacy of the different materials of this study. Collective interviews were made with the participating teachers of the same school. Prior to the beginning of the interview, participants were informed on the purpose of the interview and asked to sign a consent form. Eight teachers out of the nine that participated in this study were interviewed.

Statistical analysis

Data was normalized to zero by subtracting the median score obtained in phase 1 for each activity to the raw score of that activity. Results obtained in the different groups were analysed by Wilcox test, using the R software.

Results

Use of animated videos for science learning

Using the video 'Me and my body' (figure 1) that explores the concept of cells, we conducted a short study in three Primary schools. Each school participated in the study with 3 classes of the 4th grade, that were asked either to watch the video, to read a book (containing the same pictures as the video), or to watch the video and perform a complementary hands-on activity.

The cumulative frequency distributions of the normalised scores for the three tasks are depicted in figure 2.

Our results indicate that students in all three experimental groups (video, book, video + hands-on activity) scored significantly higher in the post-task questionnaires than in the pre-task questionnaire ($p<0.05$). A non significant decrease in the number of correct answers was observed between phases 2 and 3. Our data also indicates that students that read the book scored higher in phase 2 and 3 than those that carried out the other two tasks. Participants that watched the video alone scored marginally better in phase 2 than students that watched the video and carried out the hands-on activity. This result was inverted in phase 3, suggesting that the hands-on activity might have effects on long term knowledge retention. Differences in scores between the three tasks were not significant, for any phase of the study.

Teachers' perceptions on how to use animated videos in the classroom

As part of the study, participating teachers were interviewed, aiming to collect their perceptions on the feasibility of using these short animated videos in the classroom. Despite the fact that the activities did not address a topic that is explored in the classroom (the concept of cells is only taught in the 5th and 6th grades), teachers found it useful to introduce this topic to students of the 3rd and 4th grades, due to the connection it has to the study of the human body, which is part of the school curriculum. The teachers found all the resources provided during this study to be suitable.

Teachers referred that they usually look for educational resources from different sources, including the Internet, but they find more material in English than in Portuguese,

which is a limitation to their students. The video and the book were highly appreciated as useful resources to use in the classroom, due to the simple language used and the appealing images. In addition, the teachers that ran the video plus a complementary activity in their classroom stressed the importance of the hands-on activity, referring that students might have engaged more in that activity than in the video on it's own.

All of the teachers mentioned that they would like to run the activity again in the classroom but curiously, they suggested that the different resources should be combined, starting with the book, followed by the video and then complemented with the hands-on activity.

Discussion and Conclusion

The aim of this study was to explore the efficacy of animated videos that describe biological concepts as educational resources. The animation used in this study, the video 'Me and my body', was published on YouTube in June 2011, and since then the three versions of the video (without subtitles and with subtitles in Portuguese and English) has had over 54 000 visualizations (as of March 2014). The results presented here suggest that 9 and 10 year-old children are able to acquire knowledge from this resource, when used as a stand-alone resource, suggesting that this sort of animated videos is effective in science learning.

When comparing the animations with other resources, such as a book, or in conjunction with hands-on activities, we observed that participants provided with the video alone learned less than students that read the book. However, the difference was not statistically significant. The better performance of students that read the book might have occurred because students that watched the video did not have the possibility of pausing it and rewinding whenever they felt necessary, whereas students that read the book could devote more or less time to particular sections of information. Thus, the transient information provided by the video might have constituted a working memory issue, as it has been suggested by other authors (11), because the information it contains is complex for these ages, even if presented in a simple way. The results obtained one month after the activities by participants that saw the video and performed a hands-on activity (showed greater increase in knowledge then those that watched the video),

underscores the effect of reinforcement of new knowledge, provided by the complementary activity.

Our data suggests that animated videos are effective in engaging students in science in an entertaining way, but to take the most advantage of them as educational resources, they should be used as exploratory material, in conjunction with other resources, such as books and hands-on activities.

Captions

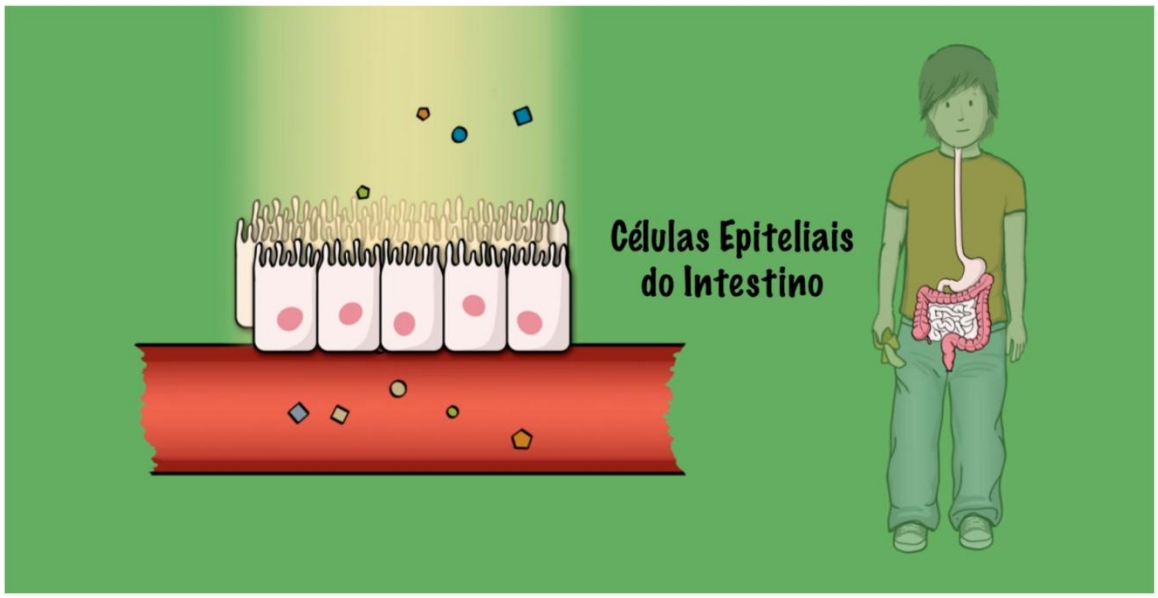

Figure 1. Frame of the video ‘Me and my body’.

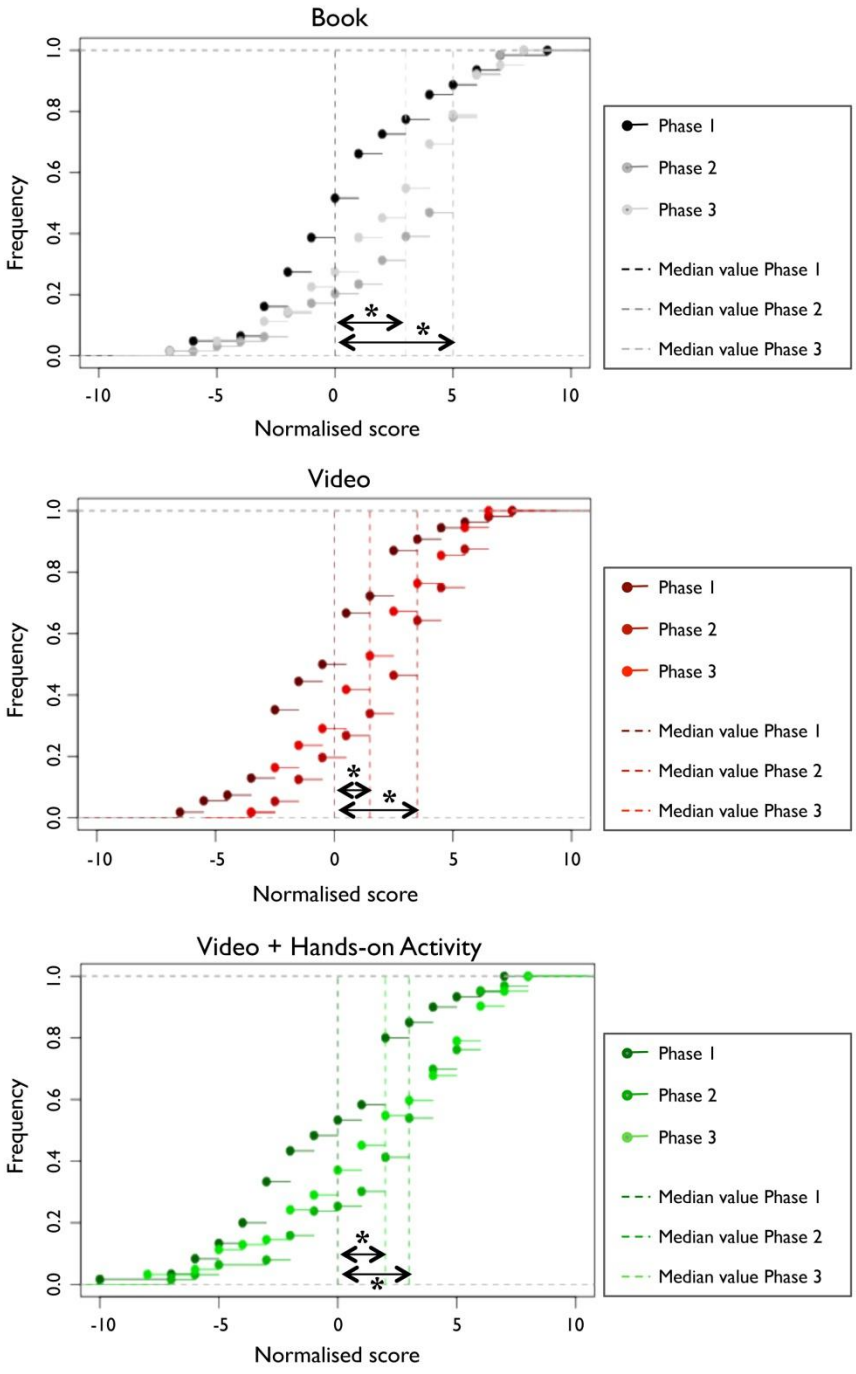

Figure 2. Frequency distribution of the normalized scores of the pre- and post-tasks questionnaires (Phases 1, 2 and 3) for the three activities (book, video and video plus hands-on activity). Darker lines correspond to Phase 1 and lighter lines to Phase 3. Vertical dashed lines indicate the median result of Phase 1, 2 and 3. Asterisk indicates a significant difference ($p<0.05$) between Phase 1 and Phases 2 and 3.

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